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- USSR -

by G. Lil'yestrand

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## INCREASING RESPONSIBILITY OF PHYSIOLOGICAL SCIENCES

This is a translation of an article written by G. Lil'yestrand in Vestnik Akademii Nauk SSSR (Herald of the Academy of Sciences USSR), Vol. 28, No. 3, March 1958, pages 40-47.

Professor G. Lil'yestrand, outstanding Swedish physiologist and pharmacologist, is known to many Soviet scientists. He took part as a guest in the Eighth Conference of the All-Union Society of Physiologists, Biochemists, and Pharmacologists which took place in Kiev in 1955.

An article by G. Lil'yestrand, "The Increasing Responsibility of the Physiological Sciences", was published in 1957 in the "Annual Review of Physiology" (Vol. 19) in which he expressed his views on a number of general problems of the development of the physiological sciences and of their role in modern society. The views of the progressive foreign scientist are undoubtedly of interest to the Soviet biologists, although certain of his opinions reflect the specific conditions of the development of science in the capitalistic countries.

By publishing with the author's permission a somewhat abbreviated translation of his article, the authors hope that it may serve towards a broader exchange of opinions among the scientists of the various countries and to a further deepening of their mutual understanding.

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The tremendous influence of scientific research on all phases of human life has long been known and has been stressed more than once before.

However, understanding by the great masses of people of the significance of science and its inherent possibilities to create both good and evil has greatly grown in the 20th century, particularly in the course of the last four decades. The experiences of the two World Wars have, no doubt, played a decisive role in this respect. It is generally obvious that the defensive might of a state is closely connected with its scientific standard and its ability of applying

the results of scientific research. Chemistry and physics occupy a leading place, attested to by such achievements as modern explosives, radar, loran, rocket weapons and, of course, by the atomic bomb. However, research in medicine has also contributed no little. Instrumentalities for conducting chemical warfare and anti-chemical defense, the successes in combating malaria and numerous other infectious diseases, the study and understanding of traumatic shock, the amazingly speedy development of aviation medicine, etc. should be mentioned here. It is highly significant that either experimental medicine, or physiology have in the widest sense of the word deeply participated in all this.

One may say with good reason that the transition from the previous to the modern methods of warfare -- when science is being widely used for destructive purposes -- marks a "turning point in the lengthy history of civilization."<sup>1</sup>. It is a tragedy that two World Wars were needed in order to convince the people of the fantastic possibilities of science. But, it would have been even worse, if the understanding of these possibilities were to be used for military purposes only. The fact that numerous important problems were solved relatively fast, when sufficient resources were put at the disposal of science, made a deep impression. Moreover, numerous new discoveries were directly applied under peaceful conditions. The people realized that science more than anything else can help in the utilization of the wealth of the earth; that it can bring people closer together, by improving methods of communication; that it can fight diseases and substantially lengthen the active period of human life. In other words, it became clear that science is in a position to speedily raise our material standard. Factually, science has entered a new phase under the conditions of contemporary society.

Naturally, the official attitude towards scientific research has undergone a substantial change in many countries. The majority of the faculties at the universities had experienced considerable difficulties in the beginning of the century in selecting competent personnel and in obtaining of resources for the carrying out of works of research. Teaching was their basic task. Merely a few institutes were created solely for the purpose of scientific research. For example, the Rockefeller Institute for

<sup>1</sup> V. Bush, in *Scientists against Time*, VII - IX (J. P. Baxter, 3rd Ed. Little Brown & Co., Boston, Mass., 473 pages, 1946).

Medical Research (1904) in the USA, the Institutes for Biochemistry, Experimental Therapy and Brain Research in Germany (1911) (Editor's note: The Institute for Experimental Medicine was created in Russia in 1890). An important step was made in England by the creation in 1913 of the Medical Research Council which received large means at its disposal. In our days, the situation has much changed in many countries. A large number of university faculties, or organizations for pure scientific research, have arisen and at times it is even difficult to obtain for them sufficiently qualified heads and workers. Their staffs have been greatly increased and their financial security has reached dimensions formerly undreamed of. Medical research councils were established and corporations were set up in many places, etc.

One may say without exaggeration, that a revolution has taken place in medical research, in the sense that favorable material and other conditions for work have appeared. We may thus hope for further progress in our fight against disease, although a heavy burden of responsibility is being put on the shoulders of the researchers. But, if we want that the results should justify our expectations, we still have to solve a great many other important problems.

It is perfectly natural that the authorities are allocating considerable financial assistance to certain practical problems, primarily under war conditions, and to a certain extent also in peace time, and that relatively large sums are appropriated for these purposes. In the final analysis, however, the prospects of obtaining valuable results are, no doubt, more favorable, if the development of basic sciences in their entirety is simultaneously encouraged. The total result is that the frontier of the unknown is being pushed away and entirely new unexpected possibilities appear of which it was previously hardly possible even to dream. There comes to mind in this connection the well-known fact of the disparity between the very large sums that are being appropriated for cancer research and the relatively modest achievements in this sphere. Langmuir gives a beautiful illustration in his own instance of the unexpected results.<sup>1</sup> After four or five

<sup>1</sup> L. Langmuir. Lilly Research Laboratories Dedication, 7-13 (Indianapolis, Ind. 128 pages, 1934).

years pretty general theoretical work in the laboratory of the "General Electric Company" on the problem of transfer of heat in the air and various gases, he received really important results for industrial research which could not have been achieved by a direct attack on the problem. He maintains that as a result of these researches the people in the USA alone are saving a million dollars every night on electric energy. Medical research provides numerous instances of a similar nature. Two of the more famous ones are: the discovery of prophylaxis by Ricket which has laid the foundation of a new and attractive field of research and the discovery of penicillin by Fleming, which has had the well-known practical consequences.

There is no doubt that the "most important factor is the responsible attitude of the people towards research that has been undertaken".<sup>1</sup> But, for the majority of scientists the essential moment consists in the choice of problems and "medical research is quite often hindered, if immediate practical results are required from it".<sup>2</sup>

The leading role of physiology in solving many clinical problems makes necessary the fruitful cooperation between the theoretical and practical branches of medical science. There are two basic ways which lead to that end. The future clinician may become himself so much acquainted with experimental medicine as to be in a position of applying its methods directly to the curing of the sick. Attempts of this type have contributed towards the great progress in the various spheres of clinical medicine. To this one may attribute the fast development of our knowledge of heart and vascular ailments and their treatment which have become widely used due to the application of long-known physiological methods. One may observe a similar situation also in other fields, for example, in the field of the diseases of the respiratory organs and the kidneys, where the modern level of the development of physiology permits of a deeper analysis. Likewise in the field of neurology, where the teaching about the potentials of activity -- formerly fenced off by the walls of the chairs of the university in physiology -- has become a valuable instrument of clinical medicine.

Another way of combining theory and practice which has yielded good results consists in the attaching of qualified physiologists to the hospitals, where they would

<sup>1</sup> A. Gregg, The furtherance of medical research, page 76 (Yale University Press, New Haven, Conn. 131 pages, 1941)

<sup>2</sup> Ibid., page 6

be able not only to observe the everyday work of the clinical laboratories, but to primarily engage in research both on instruction of their medical colleagues as well as further on upon their own initiative. Such departments do exist in many hospitals, but a great need is felt in enlarging their number.

The free interchange of results of research and of opinions which originate in the process of scientific work in all parts of the world is highly important. Unfortunately, such an interchange is being hindered at times, or is generally being made very difficult. For instance, many new achievements in science are being closely guarded because of economic and military considerations. This applies both to physiological as well as to numerous other fields of science. It is obvious that a firm which spent large sums in search of a new medicine, would not like to share with others in the results it had achieved, if it would not be assured of an appropriate compensation. It is also obvious, that new information, let us say, on the reaction of a human being to the great tensions brought about in a modern airplane and the ways of raising the ability of the human organism to withstand these pressures might give superiority to a nation, however, that free interchange of opinions in the instances described, as well as in many others, could be invaluable from a more general viewpoint. The fewer secrets, the more possibilities for the utilization of results in the various fields of science in the interest of all mankind.

However, it is often hard to find out about the results of scientific research which are not secret. The normal way of making known obtained data is, of course, to have them published in scientific literature. Theoretically this makes them accessible to everyone, but actually, in practice, it is by far not the case. The number of scientific publications is enormous. In his introductory speech at the International Physiological Congress in Boston in 1929 Krogh said that the number of articles published annually which bear a relationship to physiological problems had increased from 3,500 - 4,000 between 1904 and 1907 to 11,500 in 1921 and 20,000 in 1927.<sup>1</sup> Since that time a further increase has probably taken place, although it is hard to decide which articles should be included therein, since the section on physiology, biochemistry and pharmacology of the "Excerpta Medica" in which 5,788 publications were entered, does not by far exhaust the whole

<sup>1</sup> A. Krogh, Amer. J. Physiol., 90

list of printed articles. The enormous number of scientific publications makes it difficult for one to become acquainted with them. Every scientist has to recognize that he is able to follow the literature to a very limited extent only. He is getting a general idea of what is taking place in science from the reference journals and review articles. The old literature, including numerous articles which had, no doubt, great importance, is largely forgotten. This is to be regretted, since such articles preserve great general educational and inspirational value. In this manner the historic perspective is being lost. Let us hope that the monographs which are being planned by the American Physiological Society will help to counteract the tendency of forgetting our predecessors. The times of the heavy reference books on physiology as a whole are apparently gone. But, it is possible that such works, or monographs relating to the very active fields of science may take their place and may better respond to modern requirements.

However, in their own special fields of research scientists are not satisfied with a general review. They will be feeling a need of reading articles in extenso, or, at least, their resumes as soon as possible after they appear. The "Bibliographic Index of Medical Publication" renders a valuable aid, since it makes it possible to learn about articles that appear in print. But, here we come across a certain difficulty. Several years ago announcements about each new achievement were published in Latin and had thus become known the world over. In our time there is no general scientific language in existence. As the basic vehicle of scientific communication served in turn the French, German and English languages, although not even one of them had obtained a monopoly. It is quite doubtful, whether in the future any one of them will be accepted as the single world language of scientific publications. Moreover, many other languages play with each year an ever greater role in original publications. There is ground to assume that the fast growth and development of scientific work the world over, and even in countries which have not taken an active part in it before will lead to a wider utilization of the languages of those countries.

I was invited to attend the Eighth Congress of physiologists, biochemists and pharmacologists which took place in Kiev in 1955. I told several colleagues there that it was desirable to make their work more generally accessible. They as a rule agreed with my viewpoint, although certain of them seemingly thought that we ought to master the Russian Language, a quite unrealistic idea. In certain

circles the conviction was expressed that measures would be taken shortly towards making easier the interchange of opinions.\* Since that time the first issue of the "Czecho-slovak Review of Medicine" has appeared (Editor's note: it appears in several languages), in order "to realize the natural and warm desire of all Czechoslovak medical scientists to present their works to a really international audience."\*\* "A systematic review of all important achievements of Czechoslovak medical research by medium of complete translations of original works with annotations and surveys." This, indeed, is a step in the right direction and it is to be hoped that this praiseworthy example may be followed in certain other countries.

No doubt, possibilities for cooperation exist also in other directions. Thus, the question arises, whether it is necessary to duplicate, at times more than once, the large reference journals? We are having at the present time not only the old journal "Berichte Ueber die gesamte Physiologie," but also corresponding sections in "Excerpta Medica" and in the Soviet "Medical Reference Journal." Isn't it possible to avoid such a loss of energy in vain?

The questions touched upon here are certainly unusually important not only to physiology and medicine as a whole, but also to all sciences and should be seriously considered by our Union of Physiological Sciences and thereafter by IKSU and UNESCO.

Scientists are not the only ones who are interested in the further development of the work of research. The public at large also wants to know about it. Since the expenses are paid mainly by the whole population it is natural and important that it, too, should be informed to a certain extent of the scientific events. It is desirable that scientists deliver interesting, but not sensational scientific reports. Many physiologists have taken part in similar work. Suffice it to mention such names as Barcroft, Cannon, Carlson, Hill and Krogh. Beyond doubt, the best way toward deepening of mutual understanding among nations is by medium of frequent visits to one another.

The best way for the physiologist to establish personal contacts, no doubt, is to work for a certain period of time -- not a short one -- in a foreign laboratory. There he can devote his whole time to research and the

\*Beginning with 1956 the basic scientific journals of USSR print a resume of the inserted articles in one of the foreign languages (English, French and others). Editor's note.

\*\*Rev. Czechoslovak Med., 1, 1 (1955)

numerous factors which interfere with his work at home are not going to exert their influence there. He will find out about new methods and trends of thought and he will absorb some of the specific spiritual atmosphere of the laboratory. If the same spirit still prevails there, which was so highly valued at the Carl Ludwig Laboratory, he will also be able to follow up the other research projects performed at the institute. Thus, his time at the foreign laboratory will be spent both pleasantly and fruitfully. Quite often it leaves impressions which will have a decisive effect on his further activity, offering at the same time a chance of establishing bonds of friendship. Work under such favorable conditions falls mainly to the lot of young scientists. However, it is, beyond doubt, also useful to work in a foreign laboratory at a later period of life. The Sabbatical Year presents such an opportunity,\* but, unfortunately, in most countries it is another beautiful dream.

Although prospects of financial support for working in foreign institutes have considerably improved during the past decades, they have to be supplemented from time to time by short meetings with colleagues. International physiological congresses are highly important in this respect. I well remember the impressions of the first such congress I have attended. It took place in Groningen, in 1913. The lively speeches by Starling on Mosso and by Tigershtedt on Boro at the opening of the congress had at once created a sensation of a direct connection with classical physiology. We were able to see and hear such men as Abel, Einthoven, Holdan, Hamburger, Krogh, Pavlov and Tsunts and become acquainted with their work. I had begun research on the physiology of respiration and after some hesitation I plucked up courage to ask permission of Krogh to work with him for some time. As a result, I became his first student among foreigners at the Kopenhagen Zoophysiological laboratory. Thus, the contact which originated at the congress had an enormous effect on my future.

With the fast growth of the number of participants in congresses, it becomes ever harder to establish contacts. The thought was even expressed that international physiological congresses, like the ancient pangolins of the early geological period, have become too big, to be able to continue to exist. Preference is given to symposia (either in connection with the congresses, or independent of them)

\*Editor's note: There is a rule in a number of foreign universities which exempts a professor each seventh year from delivering lectures.

at which groups of specialists meet for several days.

Symposia have, no doubt, proven their worth, particularly those that were well prepared and at which the participants were able to study in advance the introductory reports and thus become acquainted with the essence of the problems to be discussed! I am less certain of the success of those symposia the participants at which express their opinions on the basis of their general knowledge, without any special preparation. It seems to me, that it is not necessary to publish literally everything that is being said in the course of a discussion. The literature is already too vast as it is and one has to read through the most detailed report on such a discussion before reaching the main point.

As a rule, the number of participants in a symposium is quite limited. Naturally, only those are invited, who were actively engaged in research in a given field for a certain length of time. But, many young scientists, for whom it would be very interesting to participate in symposia, are not admitted. I recall a little incident at the congress in Groningen, which is characteristic in this respect. The place for convening the next congress was being discussed at the last session. Invitations had been received from Finland and France. The opinion expressed by S. Meltzer, an American physiologist, turned out to be decisive: when he pointed out that to the young physiologists to whom the congresses are of such tremendous import -- Paris is more conveniently situated than Helsinki; Paris was chosen.

We ought not to forget that the congresses are still having a stimulating effect on the young scientists -- to whom belongs the future in our society - and provides them with an opportunity to present for discussion the results of their work. It is, however, necessary that congresses should not become too large and thereby also too expensive and complex in their organization. It seems that there are two ways of achieving that. One consists in regional meetings. Such meetings are often being arranged and turn out to be useful. Thus, special physiological congresses have taken place in the USA, in Germany, in the French-speaking countries, in Scandinavia, Russia and so on. But, of course, the really international character of a congress is lost in such a case. Another solution might be to continue the congresses on an international level, but limiting their sphere of activity to one particular branch of physiology, such as, for instance, cardiology, neuro-physiology, or endocrinology. The separation of the bio-chemists into an independent federation has been a step in the right direction. After this step, others will probably

follow. It will be thus possible to embrace not only normal, but also pathological physiology and to a certain extent also medicine. It seems to me that this could have been a valuable innovation and a means of stimulating the desired cooperation with the clinicians.

The fundamental role of physiology in the development of medical research lends special importance to the selection and preparation of a sufficient number of persons capable of carrying the torch of the knowledge already achieved farther into the unknown. Other branches of science are also experiencing an acute shortage in scientific workers. Competition will, therefore, be keen and it will be difficult to satisfy all the demands.

However, attracting the most capable students to the engaging research in the vitally-important processes - to this "best sport in the world," as Starling said at the International Physiological Congress in Stockholm, in 1926 - will not present any difficulties, if the work of the physiologists will be accompanied by satisfactory material remuneration. Otherwise, the young generation, in spite of the attractiveness of physiology, will be compelled to engage in other matters.

What qualities should the young aspirant possess, in order to justify our expectations? It is certainly hard to answer this question with definiteness. Our predictions are sometimes vindicated, but sometimes we may err in one, or another. I shall quote in this connection the beautiful words of Pavlov, with which he turned at the 87th year of his life to the young scientific workers of his country: "What would I have liked to wish the youth of my homeland, who are devoting themselves to science: First of all -- consecutiveness. I can never speak without emotion about this most important pre-requisite of fruitful scientific work. Consecutiveness, consecutiveness and consecutiveness. Get accustomed at the very beginning of your work to be strictly consecutive in accumulating information.

"Learn the rudiments of science, before attempting to scale its heights. Never tackle the following, before having mastered the foregoing. Never try to cover up the gaps in your knowledge even with the most daring guesses and hypotheses. No matter how much your eye may be fascinated by the play of colors of this soap bubble -- it will unavoidably burst and you will be left with nothing but confusion.

"Get accustomed to restraint and tolerance. Learn to do the unskilled labor in science. Study, compare, accumulate facts.

"No matter how perfect the wing of a bird may be, it would have never been able to lift it up into space, without leaning on the air. Facts are the air of the scientists. You will never be able to take off without them. Without them your "theories" are mere vain attempts.

"But, while studying, experimenting and observing, try not to remain at the surface of the facts. Do not turn into archivists of facts. Try to penetrate into the secret of their origin. Persist in search of the laws that govern them.

"The second thing is modesty. Never think that you already know everything; and no matter in what high esteem you may be held, always have the courage to say to yourself: I am an ignoramus.

"Do not allow pride to take hold of you. Because of it, you will be obstinate, where you have to concur; because of it you will turn down useful advice and friendly assistance; because of it you will lose the criterion of objectivity..."

"The third is zeal. Remember that science demands man's whole life. And if you were to have two lives, even they would not suffice for you. Science demands of man great efforts and deep zeal. Be zealous in your work and searchings."

The demands advanced by the great physiologist apply not only to the future scientists, but equally well to all other people, for instance, to the administrative workers, engineers, teachers and others everywhere. A consecutive approach, understanding of facts as a solid foundation for discussion, patient perseverance and modesty, as well as zeal and enthusiasm for work, are everywhere the most valuable qualities of man. The scientist needs the same virtues which we deem desirable in each citizen.

Pavlov failed to note one moment which is also of great importance to scientists and all other people alike: an independent and impartial evaluation of old and new observations and the correctness of the deductions derived from them. A certain amount of doubt with relation to authorities, even to the very great ones, is at times a very useful quality.

These considerations bring us to the question concerning the preparation of the future physiologist. The natural way is an adequate period of apprenticeship under a good teacher. Joint work with another student which evokes stimulating discussions at each step may be very valuable. It may, of course, be likewise useful to take part in team work - this modern form of concentrated group effort - which leads to the solution of so many difficult

problems. But, I do not think that such kind of work should predominate, as it is necessary to encourage individual achievements. In view of the highly specialized physiological researches, it is desirable that training at a good laboratory be supplemented with studies in chemistry, physics and mathematics and special courses in the important branches of physiology proper. Recently they have begun giving such courses at the Rockefeller Institute\* and also at certain other places. They are greatly needed and will help in bringing up a new generation which is well prepared to assume the study of the most important phenomena of life. Notably at this road the words of the Swedish chemist Scheele, pronounced more than 180 years ago, are being confirmed on many occasions: "There is no greater joy, than the one which is born out of discovery; this is a joy that gladdens the heart."\*\*

The author well realizes that the stated considerations do not contain anything new or original. It all applies to the problems with which each teacher of physiology is confronted in his work and which have to be discussed from time to time. Their importance increases, in proportion to the growth of the responsibility of physiology as the foundation of medical sciences. I do hope this may be sufficient justification for my article in which I touched once again upon the given problems.

\*K. Hagberg, Science, 123, 216 (1956)

\*\*C. W. Scheele, Efterlemnade bref och anteckningar, utgivna av A. E. Nordenskiold (Norstedt & Soner, Stockholm, Sweden, 490 pages., 1892)

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